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Mantle serpentinization during the formation of the Norwegian passive margin

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Volcanic- and non-volcanic passive continental margins are usually assumed fundamentally different in their structural and thermal evolutions. Non-volcanic margins are associated with intense crustal thinning, exhumation of partially serpentinized mantle, wide continent-ocean transition zones, and limited magmatism prior to seafloor spreading. Volcanic margins, in contrast, are characterized by extensive intrusive and extrusive magmatic activity at the time of break-up. They often feature an over-thickened basaltic crust and lower crustal bodies (LCB), which are often interpreted as magmatic underplating. These classic views on passive margins are increasingly challenged and Lundin and Dore, (2011) have, for example, recently argued that the inner LCBs along the Norwegian margin may be of serpentinized mantle origin, while the outer ones are more likely to have formed by mantle melting. If some LCBs along the Norwegian margin (or other volcanic margins) are made of serpentinized mantle rocks, the question arises what this implies for the structural and thermal evolution of volcanic margins?
To assess this, we use a new version of TecMod, a basin modeling toolbox, which uses the physical model for mantle serpentinization at non-volcanic margins presented by Perez-Gussinye and Reston, (2001) and Perez-Gussinye et al., (2006) augmented by reaction kinetics. The basic concept of this implementation is that the entire crust has to become brittle during extension so that seawater can reach and react with cold (<500°C) lithospheric mantle to make serpentine. Our new modeling framework now allows us to study serpentinization reactions in a full 2D thermotectonostratigraphic basin model, which resolves for lithosphere- as well as basin-scale processes (Rüpke et al., 2008, 2010). As a first test case, we have taken the 3D data set for the Vøring/Møre margin by Scheck-Wenderoth and Maystrenko, (2011) and have reconstructed the margin in a multi-2D approach. Our findings show that sedimentation (in addition to extension rate, crustal architecture, rheology, and mantle temperature) has a first order control on the onset of mantle serpentinization. We further find that serpentinization reactions are possible during the formation of the Voring/More margin and the spatial correlation between predicted serpentine bodies in the simulations and LCBs in the seismic data suggest that some of the inner LCBs may well be made of serpentinized mantle.